



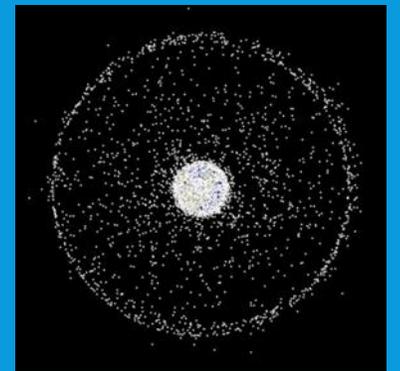
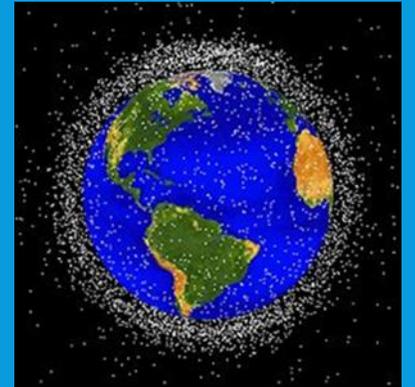
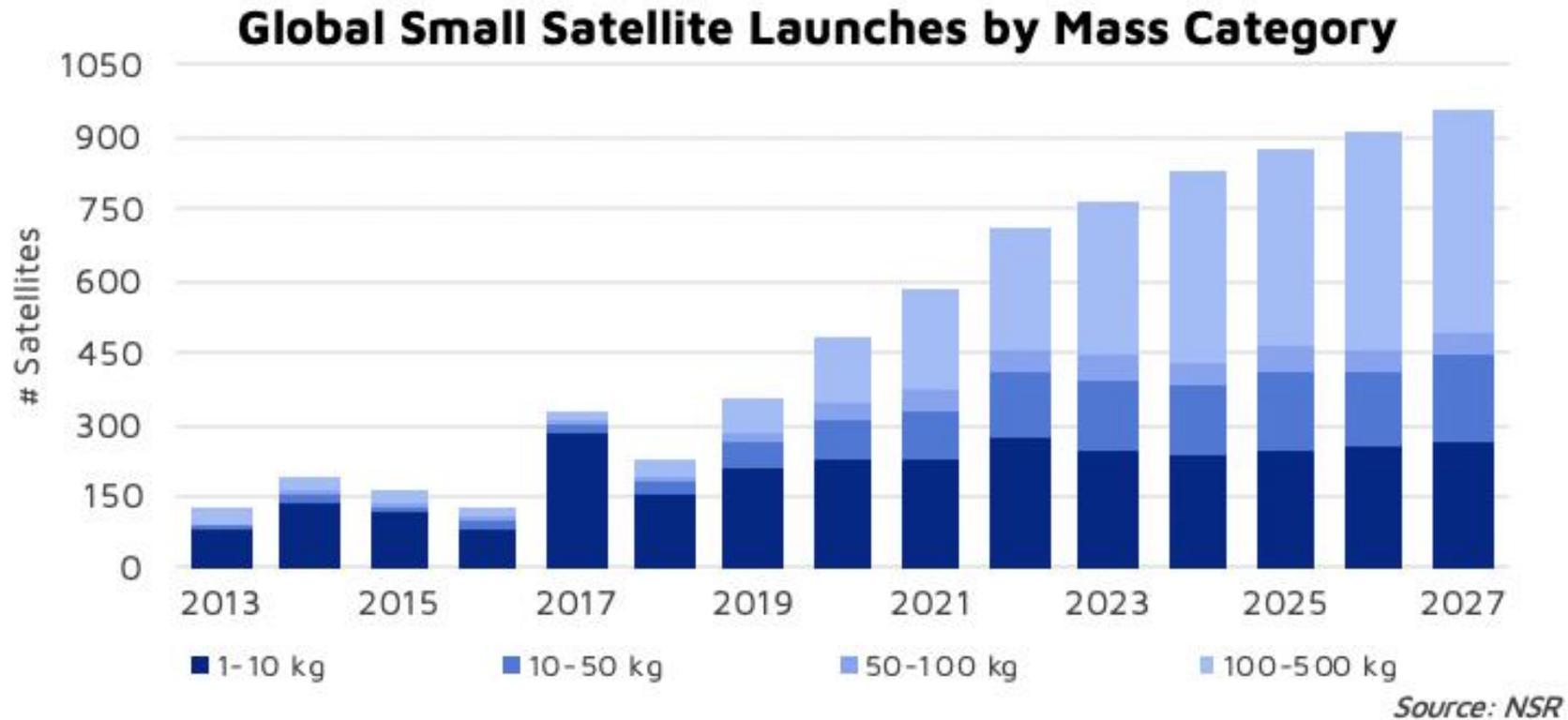
# TECHNICAL RESEARCH DEVELOPMENT AMONG CHINESE STATIONS FOR DEBRIS LASER RANGING

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# BACKGROUND INTRODUCTION



NSR's Small Satellite Markets report estimates that 39% of all small satellites launched over the next decade will be <10 kg.

# BACKGROUND INTRODUCTION

- More launching satellites and satellite constellation, and less size
- Every country concerned their space assets
- 10K of Space X, several hundreds of satellites to be launched by Chinese company to form satellite constellation
- Space traffic management, Space assets safety, Collision warning
- Protect space assets safety
  - Cooperative, controllable
  - Non-cooperative and debris, pay more attention, precise tracking and observation



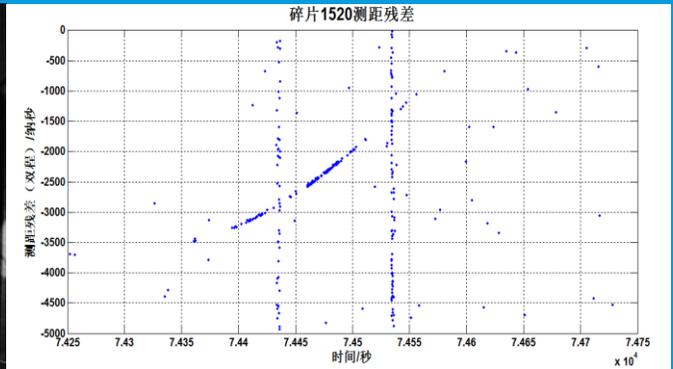
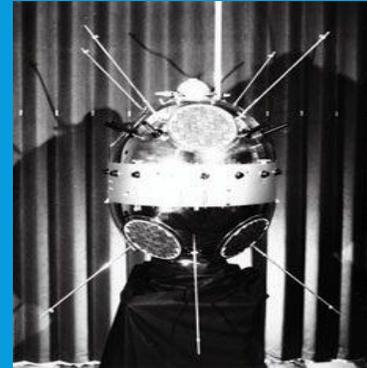
# CURRENT SATELLITE LASER RANGING STATIONS IN CHINA

- Shanghai
- Kunming
- Changchun
- Wuhan
- Beijing
- Wulumiqi (mobile )



# BACKGROUND INTRODUCTION

- Space Debris Laser Ranging:
  - 2008, Shanghai, rocket body
  - 2010, Kunming, rocket body
  - 2013, Changchun, rocket body
  - 2017, Kunming, uncooperative object



	Beginning		Current
Pulse Width	10ns	->	<ns
Laser power	30W	->	>100W
Object size	Big Rocket Body	->	Small Object
Distance	Hundred km		>3000km

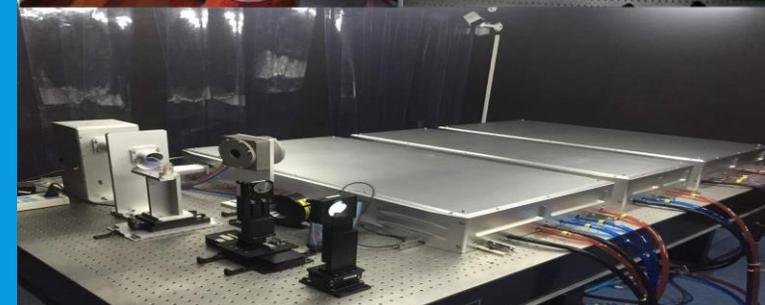
Name: **Surcal Debris**  
RCS: 0.04m<sup>2</sup> (Radar cross section)  
USSPACECOM Nr: **01520**  
Orbit: **1071 x 1174** km,



# TECHNICAL DEVELOPMENT

- Laser
  - High power
  - High frequency
  - Ns, ps

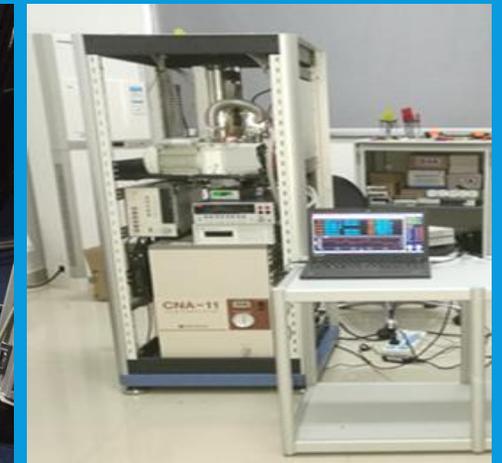
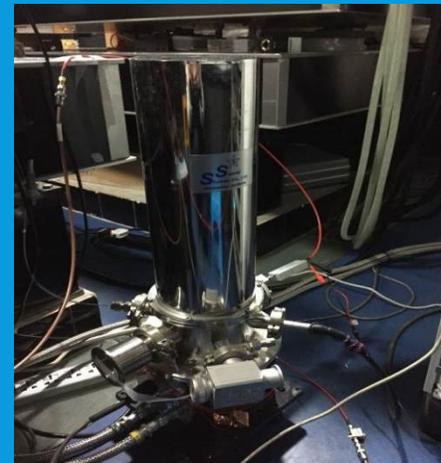
Content	Changchun	Shanghai	Kunming
Frequency (Hz)	500	200	100
Wavelength (nm)	532	532	1064
Pulse Width (ns)	10	8	7.1
Single pulse(mj)	60	300	3000
Beam Quality(M <sup>2</sup> )	<0.5	<3.5	1.7



# TECHNICAL DEVELOPMENT

- Sensor
  - C-SPAD
  - APD, G-APD
  - MPPC
  - SNSPD (Superconducting Nanowire Single-photon Detector)

Parameter	C-SPAD	SNSPD
Efficiency	20%	~10%*
Dead time	50 ns	20 ns
Dark count rate	>10 kcps	<100 cps



# TECHNICAL DEVELOPMENT

- Event Timer

- Model: A032-ET, A033-ET, GT8000SLR

- Spec

- Precision:  $\leq 10\text{ps}$ ;
- Time Resolution:  $5\text{ps}$ ;
- Recovery time:  $50\text{ns}$ .

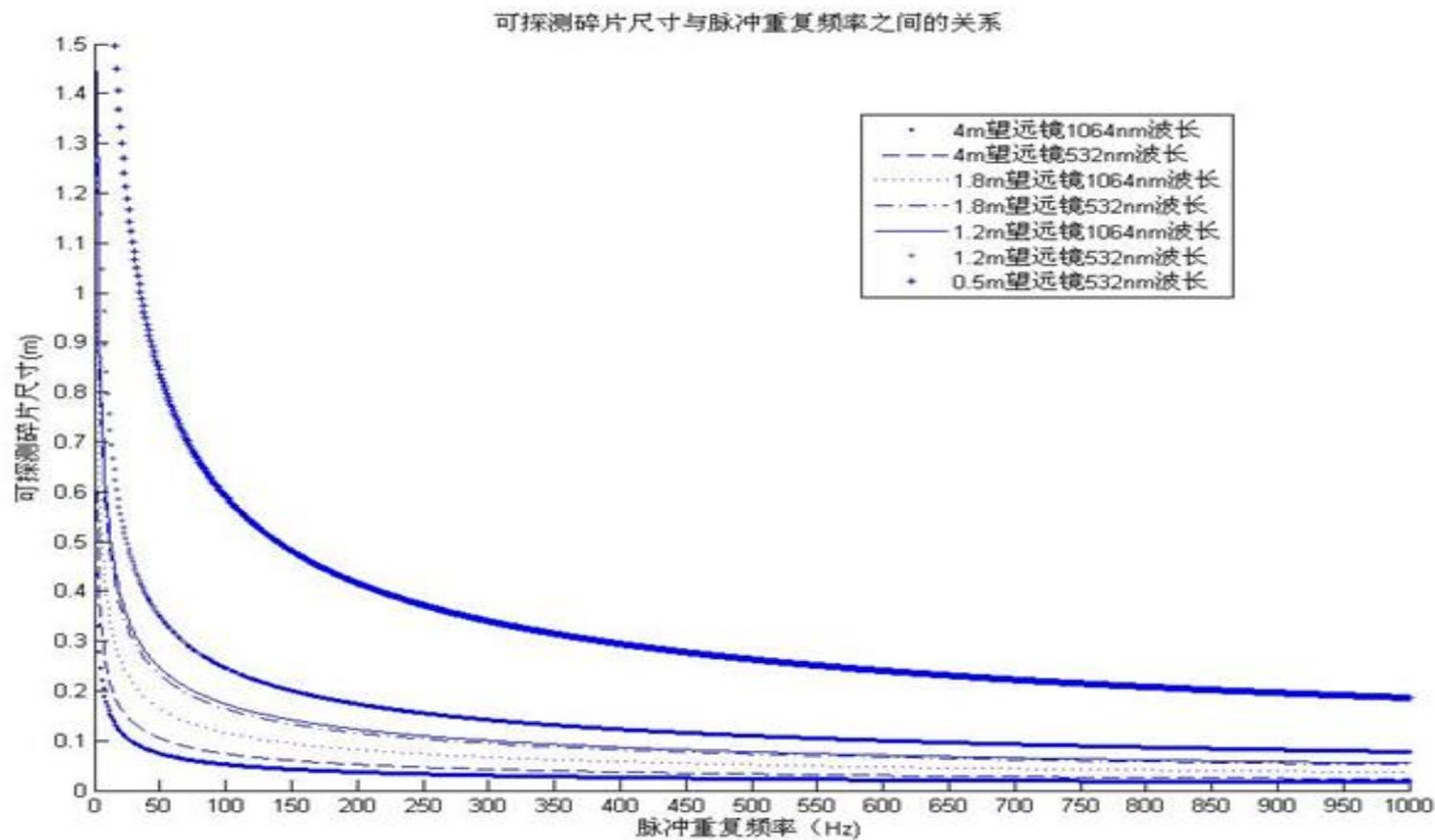


# TECHNICAL DEVELOPMENT

- Telescope
  - 50cm
  - 60cm
  - 120cm
  - Larger in the Future

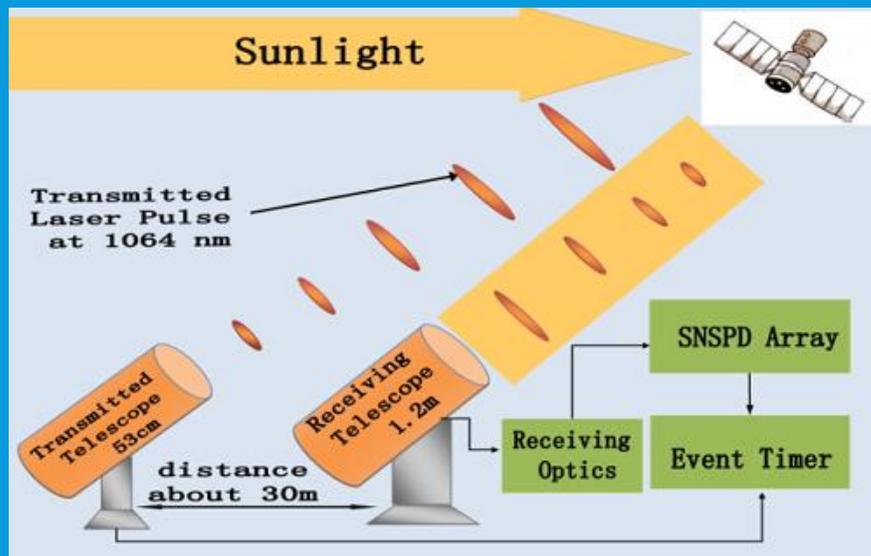


# TECHNICAL DEVELOPMENT

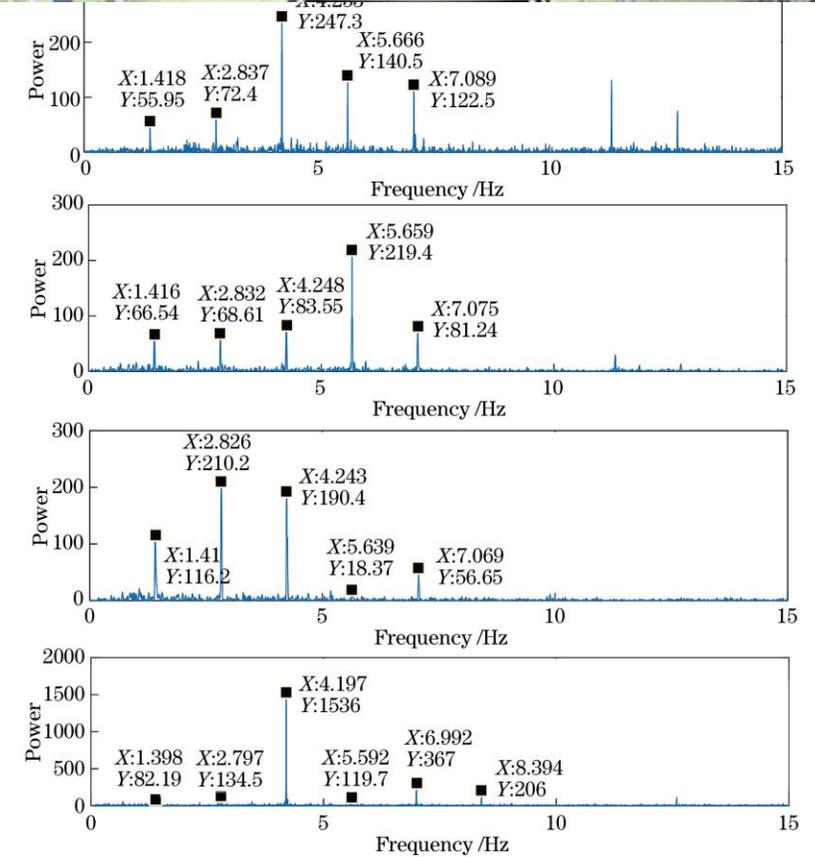


# TECHNICAL DEVELOPMENT

- Data Processing
  - Automatic echo extraction
  - Spinning satellite laser ranging data analysis
  - Ranging of Tiangong before reentry
- New Trial on Data Acquisition
  - Simultaneous measurement of the laser ranging and light curves



TOPEX



# CONCLUSION

- During the past nearly half century, with the development of space technology, the Chinese stations have improved greatly with the support of government.
- Laser ranging for space debris is developing fast and will play more important role in the space future.
- Precise tracking, accurate data processing, better cooperation and improvement on automatic deep mining of ranging data is needed to provide services to end users with higher quality.

Thanks for your attention!

